Modeling Team Cognition in Emergency Response via Naturalistic Observation of Team Interactions

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Emergency responders work collectively as an ad hoc team to save lives and infrastructures at risk, despite their varying experience, knowledge, cultural backgrounds, and difficult working conditions with high-levels of uncertainty and time-pressure. Cognition, in particular, has gained attention as a key construct to consider in collective response efforts in emergency management. Team cognition, however, has not been fully appreciated or adequately addressed in the field of emergency response (Bigley & Roberts, 2001). The interactionist perspective (or interactive team cognition) effectively captures team cognition in heterogeneous and dynamic teams prevalent in the real-world (Cooke & Gorman, 2009; Cooke, Gorman, Myers, & Duran, 2013). Although researchers in the emergency response discipline appreciate the value of viewing team cognition as interaction (Comfort, 2007; Bergeron & Cooren, 2012; Wolbers & Boersma, 2013), an associated empirical or interventional attempt using this perspective remains scarce.

Tracing the scarcity of literature back to lack of context-specific theorizing efforts (Moon, Peres, & Sasangohar, 2017), an observation-based, theory-building approach is utilized here to address this gap. The naturalistic observational study presented here is an initial effort to explore team cognition for an incident management team (IMT) as an interactive system. An IMT is an ad hoc team of command-level responders. Interestingly, an IMT is a team of functional sub-teams or sections (i.e., Command, Planning, Operations, Logistics, and Finance/ Administration). Within each sub-team there is also a team of functional units. This naturalistic observational study was conducted at a high-fidelity simulator replicating a generic IMT facility, i.e., the emergency operations training center (EOTC), College Station, TX. Interactions were observed and coded in terms of who initiated the interaction and with whom, which technology was being used, and what was communicated and for what purpose.

The purpose of this study is to develop a theoretical interactionist model of team cognition in emergency response, to inform future interventional attempts to improve team decision-making. To do so, this study views a Plans team as a cognitive system capable of managing information through interdependent, nonlinear, and dynamic interactive behaviors for perceiving (P), diagnosing (D), and adapting (A) to the changes in the status of critical elements (Adapted from Moon et al., 2017).

The proposed P·D·A model posits the following three premises: (1) a Plans team is a cognitive system where its team cognition is interactions of team members to complete a cognitive task; (2) team cognition for each of the three sub-teams of a Plans team is tied to the context-specific cognitive tasks of perceiving (P), diagnosing (D), and adapting (A) to the changes in the status of critical elements; and (3) team cognition for a Plans team is manifested as nonlinear, interdependent, and dynamic interactions within and among P, D, and A of the three sub-teams of the Plans team.

Preliminary results from a content analysis of transcribed and coded interactions suggest that an Info/Intel unit, a Situation unit, and a Section Chief unit can be hypothesized to be critical contributors of team cognition for a Plans team in terms of P, D, and A, respectively. These hypotheses can be represented with network centrality measures as follows: *Hypothesis 1. An Info/Intel unit has high in-degree and out-degree centrality with non-Plans teams. Hypothesis 2. A Situation unit has high betweenness centrality within a Plans team. Hypothesis 3. A Section Chief unit has high in-degree and out-degree centrality within a Plans team, and high betweenness centrality between the Plans team and non-Plans teams.*

The proposed P·D·A model illustrates the benefits of viewing team cognition as interaction within and among a team of teams, for context-specific tasks of P, D, and A. Most importantly, the model effectively captures the nonlinear, interdependent, and dynamic nature of team cognition as interaction in a multiteam system, or MTS (Marks, DeChurch, Mathieu, Panzer, & Alonso, 2005; Bienefeld & Grote, 2014), embedded in complex socio-technical systems, STS (Vicente, 2002). As the information processing model views an individual as a cognitive system or a human information processing system (Wickens, 1992), the P·D·A model views a team as a cognitive system capable of managing information. The interactionist perspective on team cognition helps the P·D·A model to realize its potential to extend an individual cognition model to a team level. The interactionist perspective is "compatible with the view of human-machine system as a unitary system" (Cooke & Gorman, 2009, p. 28).

In addition to the theoretical and practical implications, this study has methodological implications. Measuring interactive team cognition with network-based metrics (currently in progress) will open a new chapter. The need of incorporating a network perspective into team cognition in emergency response is in line with the literature (Wolbers & Boersma, 2013; Steigenberger, 2016). As a future work, the P·D·A model will be further developed with network and content analysis and validated through interviews with Subject Matter Experts (SMEs) involved in Hurricane Harvey.

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